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AUTHOR Mattox, John R., II
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ABSTRACT

Young drivers across the United States represent a persistent traffic safety problem. Many interventions have been imposed on these drivers but few studies have evaluated the impact of these interventions on risky behaviors or traffic safety measures. To fill this gap, a review was undertaken to examine the most rigorous methodological evaluations of youth-oriented traffic safety interventions so as to identify the most effective interventions. The results are reported here. The interventions were classified according to the ABC (antecedents, behaviors, and consequences) model of applied behavior change. Antecedent interventions include driver education, alcohol education, peer interventions, instructional parental involvement, media campaigns, and licensing policies and driving restrictions. Consequence interventions include accelerated penalties, court-ordered programs, and drinking and driving rehabilitation. Many interventions are classified as "mixed interventions" and include minimum drinking age legislation, blood alcohol concentration legislation, mandatory seat belt use, and graduated and provisional licensing. Results show that behavioral traffic interventions are highly variable in both the nature and the effectiveness of the intervention. The most effective programs employed both antecedents and consequences, instructing youth how they should or should not drive and enforcing consequences for inappropriate behaviors. Multi-component interventions, like graduated licensing, also demonstrated reductions in risk. (RJM)

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A Review of Interventions to Increase Driving Safety among Teenage Drivers

John R. Mattox, II
The University of Memphis
Department of Psychology
Memphis, TN 38142

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Abstract

Young drivers in the United States and around the world represent a persistent traffic safety problem. A wide variety of interventions have been developed to mitigate the high-risk behaviors that youth perform which lead to crashes. Those interventions include curfews, raising the minimum drinking age, driver education, graduated licensing, parental supervision, alcohol education, and grass-roots organizations (e.g., M.A.D.D. and S.A.D.D) among many others. Despite the abundance of interventions, there are few evaluations that demonstrate their impact upon risky behaviors or traffic safety measures. This review was undertaken to compile and assess the evaluations of youth-oriented traffic safety interventions. For purposes of this review, these interventions have been classified according to the ABC model of behavior change (Geller, 1988). This model asserts that behaviors are affected by interventions that are antecedent to the behavior (e.g., driver education) and consequent to the behavior (e.g., police enforcement). This review indicates that antecedent interventions are less effective at changing behaviors than consequence interventions. Programs that combine both types of intervention have the greatest impact upon behaviors and traffic safety measures.

A Review of Interventions to Increase Driving Safety among Teenage Drivers

Young drivers across the United States represent a persistent traffic safety problem. Youth are involved in traffic crashes, injuries and fatalities in disproportionately large numbers. Young drivers (15 to 20 years old) comprise less than 9% of the population, but they are involved in 16% of the crashes nationwide (NHTSA, 1994a). The fatality statistics are no less grim. Fourteen percent (7,957) of all driver fatalities were young drivers between 15 and 20 years old (NHTSA, 1994a). Motor vehicle crashes are the leading cause of death among youth ages 15 to 20 years olds.

A variety of professionals such as behavioral scientists, economists, and health professionals have developed and tested theoretical models that attempt to explain why young driver are subject to such high risk. One theory, Problem Behavior Theory (Jessor, 1987), proposed that psychosocial factors mediate young driver's unsafe behaviors. Alternately, poor decision making skills and propensities toward risk-taking have been investigated by Cvetkovich and Earle (1990), Corbett and Simon (1992), and Beirness and Simpson (1988) among others. Demographic mediators such as gender (Massie & Campbell, 1993; Popkin 1991; Popkin, Rudisill & Waller, 1988), race (Popkin & Council, 1993) and age (Cooper, Pinili & Chen, 1995; Evans, 1987) have also been studied extensively.

In addition to the plethora of theoretical studies of risky driving behavior, there are many published intervention programs designed to reduce risky driving behaviors among youth. Many examples of alcohol education programs are reviewed in McKnight (1986) and Mann et al. (1986). Lovato (1984) compiled a list of safety belt education resources for secondary school teachers. Intervention programs are published by a number of sources, most frequently by federal agencies like the National Highway Traffic Safety Administration, and the Federal Highway Administration. State organizations, such as Governor's Highway Safety Offices, Departments of Transportation, and grass-roots organizations like MADD also publish programs designed to promote traffic safety among youth (USDOT, 1985; USDOT, 1990; USDOT, 1995; Office of State and Alcohol Programs, 1993).

In contrast to the great number of intervention programs that are available, remarkably few evaluations have been published that assess the effectiveness of these programs. In this era of financial cut-backs and down-sizing, Federal and State agencies are insisting upon fiscal responsibility and stringent

effectiveness evaluations. Future publications hopefully will include evaluative results as programs are developed and disseminated. Presently, there is a paucity of youth-oriented traffic safety interventions that has been evaluated. The evaluations that have been conducted tend to focus on changes in measures of knowledge and attitudes rather than changes in objective behavioral measures for two reasons: 1) it is easier to measure changes in knowledge and attitudes, and 2) it is expensive to measure behavioral changes (Mann et al., 1986). The most important dependent variable, traffic safety measures (e.g., safety belt use rates, crash rates, fatal crash rates, etc.), are substantially underrepresented because they are even more onerous to obtain.

Effectiveness evaluations of traffic safety interventions are currently limited to topical areas. These evaluations focus upon a single type of intervention such as alcohol education programs (Mann et al., 1986) or minimum drinking age laws (G.A.O., 1987), but these reviews are now dated. Current reviews are necessary within topical areas to update intervention specialists about the most effective programs. Furthermore, a review that synthesizes effective behavioral interventions across multiple topic areas (e.g., drivers education, legislative interventions, police enforcement, and behavioral prompts among others) would also prove useful, especially a review that focuses upon interventions with young drivers.

This review is not a haphazard overview of a series of content-related publications. Rather, it is an analysis of the effectiveness of youth-oriented traffic safety interventions based on a theoretical orientation. That orientation is the ABC model of applied behavior change (Geller, 1988). The letters ABC stand for antecedents, behaviors, and consequences. According to the tenants of this model, interventions to change behaviors occur either antecedent to or consequent to a behavior. Antecedent interventions are similar to primary prevention strategies that attempt to influence behaviors before they occur. Driver education is a good example because young drivers usually enroll prior to driving. Consequence interventions occur after a behavior has been performed. Police enforcement of illegal driving activities (e.g., issuing tickets) is a consequence. For purposes of this review, intervention programs are categorized according to this model as antecedent, consequence, or mixed interventions. The latter intervention type employs aspects of antecedent and consequence interventions (e.g., a public education and information campaign paired with a zero tolerance DWI enforcement campaign). The list of interventions in Table 1 provides an outline for

this review, and they are categorized by type of intervention within the ABC model. A summary of the most effective methods with recommendations for promoting young driver safety concludes the review.

Insert Table 1 about here.

Antecedent Interventions

The clear objective of antecedent interventions is primary prevention. Interventions occur in a variety of forms as evidenced by the list of interventions in Table 1, and their effectiveness as vaccines against risk-taking behaviors is dependent on the intervention process. The processes include awareness campaigns, education, peer pressure, parental involvement, and social norms among others. Regardless of the particular intervention method, these programs attempt to vaccinate young drivers against the dangerous environment in which they will be driving and against their own risk-taking behaviors.

The review from which this presentation was derived reported many interesting effects of antecedent interventions among populations that ranged in size from classrooms to entire states. A synopsis of each intervention listed in Table 1 is presented in sequential order here to whet the appetites of those interested in this area.

Driver education. Education has been championed as a panacea for risky driving behaviors among youth. This is an intuitively appealing intervention based on the premise that extensive training can provide sufficient knowledge and skills to counteract teenage risk-taking behaviors. An early review of driver education programs (Allgaier, 1964) bolstered the intuitive appeal of this intervention. Allgaier summarized the effects of 29 studies and claimed that driver education classes reduced violations and crashes among teenage participants. However, in a later review, Lybrand et al. (1970), more accurately assessed methodological flaws in past studies and concluded that the true effects of driver education are unknown.

In an attempt to authoritatively and conclusively demonstrate the effects of driver education, the National Highway Traffic Safety Administration developed and field-tested the extensive Safe Performance Curriculum (SPC) with thirty hours of classroom instruction, and six hours of on-the-road training, which included 20 minutes of driving at night, and a less extensive Pre-Driver Licensing Curriculum (PDL). Early

returns indicated that curriculum participants gained driving skills (Ray & Brink, 1980) and that there were short-term reductions in crashes and violations for curriculum participants as compared to controls (Stock, Weaver, Ray, Brink & Sadoff, 1983). Lund, Williams, and Zador, (1986) questioned the conclusions of Stock et al. because there were group differences in driving exposure (e.g., youth in the control group reported driving more miles than the experimental group) that may have affected the crash rates per licensed driver, the dependent measure used by Stock et al. Upon reanalysis of the data, Lund et al. concluded that the crash risk among curriculum participants was 8-11% *higher* than crash risk among controls. To further muddle the answer to the question of the effectiveness of this program, Smith (1994) reported the effects of the curriculum at a later follow-up period when approximately 87% of the participants had at least 4 years of driving experience. He concluded that there was a long-term 6% reduction in crashes among the PDL participants as compared to controls, and a 10% and 9% reduction in violations among males only for the PDL and SPC groups respectively in comparison to controls.

Although the most recent evaluation of the effects of an exemplary driver education program suggests that this type of intervention results in desired effects (e.g., reduced crashes and violations), the widespread availability of driver education has distinctly negative effects upon the crash rates among the population of young drivers. Shaoul (1975) and Robertson & Zador (1978) documented that the consequences driver education include 1) younger (on average) drivers obtain a driver's license, 2) greater numbers of teenagers apply and acquire a license, and most importantly, 3) crash rates and fatalities increase. Conversely, Robertson (1980) tested the effects of removing driver education from high schools in select portions of Connecticut. Crash rates among youth dropped significantly when compared to rates among youth where driver education was available.

The verdict on the effectiveness of driver education upon crashes is this: driver education curricula provide useful (some would argue necessary) information and skills, but these skills do not counteract the increased crash risk that results from the increased number of young, inexperienced drivers on the road.

Drinking and driving abatement through alcohol education. Drinking and driving education programs are designed to prevent drinking and driving among youth, and such programs proliferate (e.g., American Automobile Association, 1975, 1976, 1978; Bishop, 1974; Students Against Drunk Driving, 1982). The instructive orientations of education programs vary considerably, but Mann, Vingilis, Leigh,

Anglin & Blefgen (1986) have classified programs in three ways: 1) information processing, 2) affective processing, and 3) learning theory. The information processing orientation focuses on supplying participants with information about drinking and driving, assuming that the information will lead to changes in knowledge, attitudes, and behaviors. The affective processing orientation assumes that behavior changes are contingent upon affective arousal, usually achieved through one of two methods: 1) presentation of negative consequences (e.g., through films) associated with alcohol-related crashes, and 2) personal involvement in group discussions, values examination, and decision making skills. The learning theory orientation employs conditioning and skill development to resist behaviors leading to drinking and driving.

Very few of the evaluations examined for this review used dependent measures of primary interest such as observed drinking and driving behaviors, riding with a drinking driver, or DWI convictions. These are the ultimate measures of the effectiveness of driver safety programs. Because these measures were not available, the next best measures, typically self-report measures of attitudes and behaviors, suffice as effectiveness measures. Among the three orientations (e.g., information processing, affective processing, and learning theory), all three tend to demonstrate changes in knowledge and attitudes, and to some degree behaviors. However, the most effective method appears to be the learning theory orientation. Wodarski & Broadnick (1987) demonstrated changes in knowledge, attitudes, and behaviors that were sustained upwards of two years after the intervention.

Peer interventions. Scant evaluations exist that address the effectiveness of peer intervention efforts to increase young driver safety. Among the research that does exist are four articles focusing on peer intervention to prevent driving after drinking, and two evaluations of a Students Against Drunk Driving (S.A.D.D.) programs.

The effects of peer intervention projects have demonstrated mixed results. Programs that instruct youth how to intervene with their peers and allow them to practice those skills demonstrated increased willingness and intention to intervene, and some increased intervention behaviors (McKnight, Mason, McPhereson, & Oates, 1979; McPhereson, McKnight, & Weidman, 1983; McKnight and McPhereson, 1986). Evaluations of S.A.D.D. programs—the grass-roots peer intervention campaign—produced less encouraging results. Surveys of participants in S.A.D.D. programs showed attitudinal changes against

drinking and driving, and slight but non-significant decreases in drinking and driving and riding with a drinking driver (Klitzner, Greunewald, Bamberger, & Rossiter, 1994; Leaf and Preusser, 1995).

Instructional parental involvement through certified practice. Certified practice is a method of supervised training for young drivers that goes beyond any supervision provided during driver education programs. It is a policy that is usually enacted as part of a graduated licensing program to provide young drivers with experience while being closely supervised. Parents of adolescents assume the role of supervisor, riding with their adolescent as he or she practices driving with a learner's permit. In states that have enacted this program such as Maryland, the parents are required to certify that their child has gained a certain amount of experience prior to testing for a full unrestricted license. Proof consists of a catalog of driving trips maintained by the parent. Adolescents support this form intervention. Of 19,000 high school students surveyed by Preusser, Williams, and Lund (1985), 82% agreed that parents should spend more time supervising adolescent driving.

As a component of Maryland's graduated licensing system, certified practice was never fully implemented (McKnight, Hyle, & Albrecht, 1983). The extent to which certified practice actually occurred was estimated at 30%. That is, 30% of the parents of youth receiving a license supplied documentation of certified practice. While the licensing program in Maryland was associated with a 5% reduction in young driver crashes during the day, and a 10% reduction in convictions, the effects of parent-certified practice could not be separated from other components of the graduated licensing system. Similarly, in California, parental certification was mandated in 1983, but the amount of parent-supervised practice per driver was not tracked (Hagge & Marsh, 1988). The effects of certified practice were indistinguishable from other graduated licensing components.

Media campaigns. The potential impact of media interventions is vast. National campaigns promoting safety among adolescents have been conducted, but the process and outcome evaluations of such campaigns have demonstrated no positive effects (Swinehart, 1981). Community-oriented campaigns, particularly those campaigns that combine media and educational programs, appear to be somewhat effective in changing knowledge and attitudes (Collins & Cellucci, 1990, Dearing, Caston, & Babin, 1991). Regarding areas of traffic safety other than drinking and driving such as safety belt use, speed, and driving

while fatigued, the effectiveness of media campaigns on a national or community level have not been documented.

Licensing Policies and Driving Restrictions. Several licensing policies and driving restrictions have been passed by legislatures to prevent young drivers from putting themselves and others at-risk while learning how to drive. The policies and restrictions include: requiring a learner's permit, delayed licensing, restrictions concerning motorcycle use, nighttime driving restrictions, limiting the use of free-way systems, limiting the maximum speed at which young drivers may travel, and limiting the number of passengers a young driver may carry. While these interventions are legislative in nature and thus have antecedent and consequence components, they have been categorized as antecedent interventions because they are primary prevention strategies. Other legislative interventions such as minimum drinking age laws are also preventive, but have clear consequences for the performance of inappropriate behaviors.

Prevention-oriented driving restrictions have great potential for decreasing crashes and subsequent injuries and fatalities among novice drivers. Many restrictions have not been evaluated. However, some restrictions like mandatory learner' permits, delayed licensure (Ferguson, Leaf, Williams & Preusser, 1996), and curfews (Preusser, Williams, Zador, & Blomberg, 1984; Preusser, Zador, & Williams, 1993) are associated with marked decreases in crashes, injuries, and fatalities.

Table 2 summarizes pertinent information about the antecedent interventions that have been discussed.

Insert Table 2 about here.

Consequence Interventions

Accelerated penalties. Accelerated penalty statutes sanction young drivers more heavily than older drivers for the driving same offense, and the method of assigning penalties varies per state. In some states a greater number of points are assigned to adolescent drivers than adult drivers for the same offense. Other states suspend licensure for offenses occurring during a learner's permit period or even during the first year of full licensure. Sanctions for accruing an excessive amount of points through crashes or violations may also be applied at a lower point level for youth than for adults. The intent of these sundry statutes is to

bring contingencies (e.g., suspension, or driver improvement classes) to bear upon youth sooner than the same contingencies would be brought against adults.

Four states, Michigan, California, Maryland and Oregon have implemented and tested the efficacy of accelerated penalty systems. In Michigan, young drivers who were subject to the accelerated point system condition were involved in fewer crashes than drivers in the comparison group six months after the system was initiated. This effect disappeared after one year (Evay, Edwards, & Lee-Grosselin, 1987). A separate experiment with accelerated point systems in Michigan was conducted by McKnight & Edwards, 1987), and it involved a three step process for adolescents involved in the experimental condition. After a first offense, a warning letter was sent to the driver. After the second offense, participants were subject to a group reexamination, and after a third offense, drivers had their license suspended for a two-week period. Both convictions and crashes were reduced among young female drivers who received a warning letter or faced reexamination. Among male drivers, only the 2-week suspension component was effective in reducing convictions and crashes.

In California, Maryland, and Oregon accelerated penalties interventions were couched within each State's graduated licensing program. Separate evaluations (Hagge & Marsh, 1988; McKnight, Hyle & Albrecht, 1983; Jones, 1994) were conducted in each State, and all claimed that accelerated penalties were effective in reducing crashes and violations. However, these claims are suspect because none of the evaluations assessed the singular effects of this component within the more extensive graduated licensing intervention.

Court-ordered driver improvement programs. Driver improvement programs are designed to refresh young drivers with rules of safe vehicle operation, and in addition address issues like peer pressure, dangerous situations, and high-risk driving behaviors. These topics are covered as preventive medicine--behavioral vaccines against future crashes and violations. Social skills training and problem solving techniques, even role-play, are used as methods of avoiding peer pressure, dangerous situations, and high-risk behaviors. An example of such a program is the Alive at 25 curriculum developed by the National Safety Council (1995).

The effects of driver improvement programs often are confounded by accelerated penalty programs, because driver improvement programs are often the accelerated penalty that young drivers face

for crashes or convictions. For example, in Maryland under the State's graduated licensing system, young drivers were required to attend an eight-hour education program after being involved in two crashes or violations (McKnight, Hyle, & Albrecht, 1983). Thus, the education program becomes an accelerated penalty.

Accelerated penalties and driver improvement programs are listed among several components of graduated licensing systems in Maryland and California. While the graduated licensing programs as a whole were successful in both states (Hagge & Marsh, 1988; McKnight, Hyle, & Albrecht, 1983), the effects of individual components such as accelerated penalties and driver improvement programs were not evaluated. Thus, the effectiveness of each of these components is unknown.

Conviction- and crash-free period prior to full licensing. Both the state of Maryland and the city of Ontario, Canada have set conviction and crash standards for young drivers operating with a learner's permit. For six months young drivers in Maryland are required to maintain a conviction- and crash-free record in order to be eligible for full licensing. The extent to which this component singularly contributed to that State's reductions in crashes and convictions among youth is unknown (McKnight, Hyle, & Albrecht, 1983); it too is couched within the graduated licensing system. In Ontario, young drivers must operate without a suspension for two separate one-year periods. During this time, young drivers are subject to accelerated penalties license suspension at half the point value of adult suspension. In Ontario, this mandatory suspension-free legislation is associated with a 7% decrease in crashes and an 11% decrease in convictions among drivers under 20 years old (Garys, Pang, & Rosenbaum, 1983).

Drinking and driving rehabilitation programs. Rehabilitation programs are tertiary interventions designed to prevent recidivism through education and treatment programs. Rehabilitative education programs provide offenders with information without dealing directly with individual drinking problems, whereas, treatment programs attempt to educate participants about their drinking problems as well as modify their drinking behaviors to prevent recidivism. The most extensive review of rehabilitation programs was conducted by Mann, Leigh, Vingilis, and DeGenova (1983), but none of the articles that were reviewed focused exclusively on young offenders. This is not surprising considering that the greatest proportion of DWI offenders tends to be age 21 and older.

Two studies were found that address recidivism rates among young drivers as sub-samples of the treatment groups, but they are methodologically flawed. Donovan et al. (1990) suffered large rates of participant attrition in treatment and comparison groups. Nickel (1990) compared non-equivalent groups that were judged differentially to be fit to drive prior to receiving treatment. The findings of these articles conflict, possibly due to these methodological flaws and possibly due to the difference in the types of rehabilitation programs. Donovan et al. (1990) found that their education program was more effective among younger drivers, while Nickel (1990) found that young drivers were affected least by the treatment programs. Conclusions drawn from these studies are spurious at best. Future research on this topic which employs larger samples of youth who are assigned randomly to conditions will benefit the field in answering the question of the effectiveness of rehabilitation programs.

Table 3 contains information about consequence interventions reviewed above.

Insert Table 3 about here.

Mixed Interventions

Minimum drinking age legislation. The constituents of every nation suffer tragic personal losses when young persons die. The nation also suffers as it unable to redeem its investment in its future. The tragedy of such losses are exacerbated when one considers that approximately 30% of those deaths among 15 to 20 year old drivers were alcohol-related (NHTSA, 1994a). In the early 1980s alcohol-related fatality rates among young drivers were such a health concern for the nation that the 98th U.S. Congress held a hearing to address the need for a national minimum drinking age law. Congress requested a full definition of the problem and wished to know whether raising the minimum drinking age would remedy the problem. Behavior scientists proposed multiple methods for breaking the behavioral sequence of events that leads to drinking, driving while impaired, and subsequent fatal crashes. Those interventions included alcohol education, rehabilitation, media campaigns, and grass-roots organizations (e.g., S.A.D.D. and M.A.D.D.) among others. Some of these interventions have been reviewed here (e.g., alcohol education, media campaigns, and grass-roots organizations) with little demonstrable effect upon driving behaviors. Two of the most successful interventions are raising the minimum drinking age and lower the legal BAC limit.

Minimum drinking age (MDA) laws, and blood alcohol concentration (BAC) legislation are two interventions among the many designed to reduce alcohol-related youth fatalities, but they are distinguishable from other interventions because they contain both antecedent and contingency components. These forms of legislation are antecedent in nature because they are instructive prior to the performance any drinking-driving behaviors. MDA laws instruct youth that consumption of alcohol is prohibited for anyone under the age of 21. BAC laws instruct that excessive amounts of alcohol will impair decision-making and driving skills. The instructive nature of legislation is also paired with enforcement of consequences. Minors that drink and drivers with unacceptable BACs suffer fines, loss of license, incarceration, and other penalties. The manner in which instructions and enforcement of consequences interact indicate that legislation is both an antecedent and consequence intervention.

Two years after the 98th U.S. Congress held hearings on the effects of MDA laws, the Federal Highway Administration (FHWA) mandated that every state raise the legal minimum drinking age to 21. FHWA applied its own contingency to make the mandate effective; those states that did not comply were threatened with the loss of millions of dollars in Federal highway funds, and all states are currently in

compliance. Yet, the question remains, did the Federal mandate reduce alcohol-related crashes and fatalities among youth?

Several publications answer this question affirmatively. The landmark document that assessed the effects of MDA legislation is a literature review published by the General Accounting Office (1987). The report selected and reviewed the 49 most empirically sound publications available on the topic. Dependent measures of interest included alcoholic beverage consumption, drinking and driving behaviors, and crashes. Results indicated that increasing the minimum drinking age reduces alcohol consumption and drinking and driving behaviors among youth affected by the legislation. Subsequently, alcohol-related crashes also declined among this age group, and the magnitude of the varied per state and the dependent measure selected.

Additional investigations of MDA legislation (MacKinnon & Woodward, 1986; O'Malley & Wagnaar, 1991) have been published since GAO (1987), and all have produced similar results. Generally, increases in the MDA are associated with decreases in alcohol-related fatalities. Conversely, decreases in the MDA result in increases in alcohol-related fatalities (Brown & Maghsoodloo, 1981; Smith and Burvill, 1986).

Blood alcohol concentration (BAC) legislation. State legislatures designate the blood alcohol concentration level at which it is illegal to operate a motor vehicle, and this level varies per state for adults (NHTSA, 1994b). Because alcohol is an illegal substance for teenagers, most states maintain that any level of alcohol is intolerable for youth, but again, the tolerable BAC level varies from state to state. In Virginia, the tolerable amount is .00%, whereas the level in Maryland is .02%; the level in Connecticut and Rhode Island is .04% for those under 18 years-old, and the level in Georgia and Alabama is .06% (Hingson, Heeren, & Winter 1995). The consequences of alcohol use among adolescents are also varied. Some states immediately revoke a teenager's license when any measurable amount of alcohol is detected. Others apply court sanctions such as education or rehabilitation.

Several published studies have examined the effects of lowering BAC levels for youth upon alcohol-related traffic fatalities for this age group (Blomberg, 1992; Hingson, Heeren, Howland, & Winter, 1991; Hingson, Heeren, & Winter, 1995), and the results are similar from every study. The most extensive study was conducted by Hingson, Heeren, and Winter (1995) in which data from 12 states with changes in

BAC level and 12 states without changes were examined. As an indicator of drinking and driving among teenagers, Hingson et al. used single vehicle nighttime crashes among 15- to 20-year-olds as a dependent measure. States that had lowered their BAC levels did so to varying degrees. Eight lowered the maximum tolerable BAC to .00%, eight lowered the tolerable BAC to .02%, and eight other states lowered BAC levels between .04% and .06%. Results indicate that fatal nighttime crashes involving single vehicles declined 16% among young drivers in states that lowered legal BAC levels. This measure declined one percent among youth in the comparison states. Among adults, this measure declined 5% and 6% in the lowered BAC states and the comparison states, respectively. The authors also determined that .00% and .02% tolerance laws were more effective than .04% to .06% laws at reducing nighttime fatal crashes among youth.

Like MDA legislation, BAC laws have demonstrated a substantial impact upon alcohol-related crashes among youth, and a dose-response curve appears to be in effect for this intervention. The lower the tolerable BAC, the greater the reduction in crash risk.

Mandatory safety belt use. During the past decade, legislators have advocated safety belt use. Safety belt legislation affects drivers of all ages, but it is particularly important that legislation target young high-risk drivers so that safety belt use becomes habitual. Several community-oriented safety belt programs have been implemented and evaluated (Campbell, Hunter, & Stutts, 1984; Cope, Moy, & Grossnickle, 1988; Geller, Bruff, & Nimmer, 1985) with successful results, but Campbell et al. (1984) is the only such program that focused on teenage drivers.

Campbell, Hunter and Stutts (1984) successfully demonstrated that education and incentives are effective methods of increasing belt use rates among high school students. Using an A-B-C-A design, the authors collected baseline data (A), implemented an education program highlighting statistics and dangers of not wearing safety belts (B), offered three different cash incentives (C), and collected follow-up data (A). During baseline, the shoulder belt use rate averaged around 20%. It ranged from 28%-39% during the education campaign, and rose to a low of 46% and a high of 54% during the incentive stage. At follow-up, use rates dropped to levels between 29% and 40%. These data suggest that education and incentive campaigns can effectively elevate the belt use rate among high school students.

No other evaluations of safety belt interventions specifically targeting young drivers were found. However, the effects of safety belt interventions have been successful among mixed age populations. One method of increasing safety belt use is to combine both legislation and enforcement. With the advent of safety belt legislation, an increase in antecedents like public education through the media occurred. Concomitantly, belt use rates tended to rise prior to the enactment of a state or local mandatory use law. Use rates were sustained for a short period through enforcement efforts before declining toward the original rate in the area (Cope, Johnson, & Grosnickle, 1990; Hunter, Stutts, Stewart, & Rodman, 1990; Thyer & Robertson, 1993). The decline was typically associated with decreased enforcement efforts. Locations with mandatory use laws stipulating primary enforcement statutes are associated with higher belt use rates than locations with secondary enforcement statutes (Campbell, Stewart, & Campbell 1987).

Graduated and provisional licensing. Graduated licensing and provisional licensing are similar forms of legislation designed to reduce crash risk among adolescents while providing young drivers with the freedom to gain driving experience and develop safe driving skills. The ultimate goal of both graduated and provisional licensing systems is the same: to reduce crash rates and subsequent injury and fatality rates among young drivers. While the goal of each system is common, the methods used by each are based on divergent theoretical orientations. Graduated licensing systems allow young drivers to gain driving experience and demonstrate driving competency. Experience and competency are rewarded progressively with more driving freedom by removing restrictions until a full, unrestricted license is obtained (US DOT & AAMVA, 1996). Provisional licensing systems facilitate learning and experience acquisition by allowing young drivers to learn with few initial restrictions. These systems offer full or nearly full driving privileges to all young drivers upon licensure that are retained through safe driving behaviors that do not result in crashes or moving violations. Some restrictions do apply, such as hours of operation and number of passengers. When young drivers are apprehended for a moving violation or are involved in a crash, privileges are forfeited to varying degrees in relation to the offense.

Graduated and provisional licensing systems consist of a variety of interventions that operate simultaneously to reduce crash risk among adolescents. Seventeen various intervention components from states with graduated licensing systems in this country (e.g., California, Florida, Kentucky, Maryland, and

Oregon) as well as other countries (e.g., New Zealand) were identified during a graduated licensing conference at The University of Memphis (Henning et al., 1996), and these components are listed in Table 4.

Insert Table 4 about here.

The components that comprise the graduated licensing systems reviewed here varied across each program, but the effects of each program were positive. It appears that the combination of the various components positively impact young driver behaviors. Across states, fewer drivers obtained their license when they were of eligible age, some spent more time driving with a learner's permit, and driving test failure rates were lower, suggesting increased knowledge and skill acquisition. The consequence of these varied components of graduated licensing systems is that young drivers have approximately 5%-10% fewer crashes and convictions.

Table 5 contains information about the effectiveness of each mixed intervention program reviewed above.

Insert Table 5 about here.

Conclusion

The primary goal of this review was to examine the most rigorous methodological evaluations of youth-oriented traffic safety interventions with the express intent of determining the most effective interventions. This goal was met with interesting results. Behavioral traffic interventions that target young driver safety are highly variable in both the nature and the effectiveness of the intervention, even within the framework of the ABC model (Geller, 1988). For example, safety promotion through standardized driver education classes—a program that expressly addresses unsafe driving in order to "inoculate" young drivers from risk—is less effective than nighttime restrictions (curfews)—an intervention designed to reduce crime not crashes. The most effective programs, in particular those that demonstrated a direct impact upon traffic safety measures such as safety belt use, crashes or traffic fatalities, are highlighted below. Additionally, several methodological issues relevant to the literature in this topical area are discussed. Finally, questions are raised concerning future research.

Effectiveness. Within the framework of the ABC model of applied behavior change (Geller, 1988), the most effective type of interventions employed both antecedents and consequences. This is not to say that alone antecedent or consequence interventions are ineffective. The most effective programs instruct youth how they should or should not drive and enforce consequences for inappropriate behaviors. Examples of such interventions include minimum drinking age laws, blood alcohol concentration laws, and delayed licensure laws. Multi-component interventions like graduated licensing also demonstrated reductions in risk. Finally, those interventions that actively involved young drivers in learning showed gains in knowledge, attitudes, and sometimes behaviors. As examples, young drivers who participated in the SPC and PDL driver education courses acquired more demonstrable driving skills than non-participants (Ray & Brink, 1980). Role-play and intervention-oriented classes (McKnight & McPhereson, 198 , Wodarski & Bordnick, 1987) helped participants develop skills to resist pressures to drink and drive, to resist riding with a drinking driver, and to prevent peers from driving after drinking.

Methodology. Several factors within the effective interventions may be confounded by other factors. For example, the mixed interventions are confounded by the fact that they are all legislative interventions. That is, it is not known whether the interventions are effective because they have both antecedent and consequence properties or because they consist of state policies, supported by the legislature, executive, and judicial branches. As a further example, graduated licensing programs have multiple intervention components. The effectiveness of these interventions is as likely attributed to the sheer number of components affecting young drivers as it is to the nature of each component.

The evaluation method most often used to determine the effectiveness of interventions was the quasi-experimental design. In most cases this method was used out of necessity due to the difficult impossible nature of randomly assigning participants to conditions. While this design lends strong supporting or disconfirming evidence to an evaluation, it does not conclusive determine the effectiveness of an intervention. Care and planning should stressed in the future to expend the extra resources to conduct experimental as well as quasi-experimental designs.

Several dependent measures were included in this review as measures of effectiveness. Those measures assessed changes in attitudes, knowledge, skills, mood, and behavior. While it is important to

demonstrate changes in dependent measures such as attitudes, knowledge, skills and mood, the ultimate criteria of effectiveness is behavior—traffic safety related behaviors in particular. In those studies where authors measure only attitudes or knowledge, the question of whether the program effects behaviors is left unanswered. Because changes in attitudes, knowledge, skills, or mood do not necessarily lead to changes in behavior, it is important for future research to measure behaviors. The behaviors of interest include pre-driving behaviors such as alcohol-consumption as well as actual driving behaviors. Further, the final criteria are the products of these behaviors in the form of crashes, injuries, and fatalities. Unless these measures are assessed, the question that motivates these programs "Did this intervention improve safety or decrease risk?" will remain unanswered.

As with many reviews, many new questions are raised as others are answered. Having digested much of this literature over an extended period, I would like to direct the attention of those who are interested to some questions I have developed. First, based on the assumption that driving experience is one of the most important factors leading to reduced risk, what programs can be developed (beyond graduated licensing) to allow young drivers to gain safe on-the-road driving experience? Second, how can young drivers be more involved in being role-models or setting examples for safety among their peers? Third, how can parents become involved more systematically with the driving education and monitoring of their adolescents? Fourth, how do court-ordered punishments affect young drivers? Fifth, mandatory safety belt laws have been passed and use rates are climbing; what are cost-effective methods reach the non-users? Finally, the most effective programs tend to be legislative. Is legislation necessary for future safety?

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Table 1 Categories of youth-oriented traffic safety interventions.

Antecedent Interventions	Consequence Interventions	Mixed Interventions
• Driver education	• Accelerated penalties	• Minimum drinking age legislation
• Drinking & driving education	• Court-ordered driver improvement programs	• Blood alcohol concentration legislation
• Peer intervention	• Conviction and crash free periods	• Mandatory safety belt use
• Instructional parental involvement through certified practice	• Drinking and driving rehabilitation programs	• Graduated and provisional licensing programs
• Media campaigns		
• Licensing policies and driving restrictions: learner's permits delayed licensing motorcycle restrictions nighttime restrictions non-freeway use reduced speeds limited passengers		

Table 5.
Components of graduated licensing systems

Require learner's permits prior to full licensing	Set a minimum period for driving with a permit prior to full licensing
Extend the period for which permits are valid	Restrict who can supervise young drivers during the permit phase
Require parental certification of practice	Longer waiting periods after failed knowledge and driving exams
Create a provisional license for young drivers	Set restrictions on passengers a young driver may carry
Restrict the hours during which young drivers can operate a motor vehicle	Restrict the type of vehicles used by young drivers
Set lower speed limits for young drivers	Enforce safety belt use by young drivers
Require driver education	Require conviction-free periods prior to provisional and full licensing
Establish lower blood alcohol concentration levels	Accelerated driver penalties and driver improvement programs
Increased parental involvement in driving offenses	

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